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# Potentiality of halophytes as animal fodders under arid conditions of Egypt

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***RESUME –*** *"Potentialités des halophytes comme fourrage pour bétail dans les conditions arides d'Egypte". Les halophytes sont largement distribuées dans plusieurs régions d'Egypte dû à la présence de nombreux marais salants le long des côtes de la mer Méditerranée et de la mer Rouge et à l'intérieur des terres. Les plantes halophytes présentent de multiples usages pour la fixation des dunes de sable, comme coupe-vent, combustible, etc. En raison du manque critique d'aliment pour le bétail dans les régions désertiques, en particulier durant les saisons sèches, l'utilisation des halophytes comme fourrage animal est en train de devenir nécessaire et revêt une grande importance. Cet article vise à résumer le résultat de recherches et d'expérimentations appliquées sur le rôle des plantes halophytes pour l'alimentation des animaux en milieu désertique en Egypte. Les principaux usages des plantes halophytes natives sont indiqués dans cet article qui présente également quelques données sur les espèces halophytes dominantes concernant la composition chimique, les constituants fibreux et la palatabilité. La valeur nutritionnelle et l'utilisation des halophytes sous différentes formes, en frais, sèches ou ensilées pour les ovins et caprins, sont également discutées. Il semble que certaines des halophytes natives et exotiques présentent de grandes potentialités en particulier comme fourrage animal dans les conditions arides d'Egypte.*

***Mots-clés :*** *Halophytes, animaux, aliment, ingestion, digestibilité, valeur nutritionnelle, désert.*

## Introduction

Feed resources deficiency is considered one of the basic constraints to improving animal productivity in arid and semi-arid regions in Egypt. Improving nutritional status of desert grazing livestock (sheep, camels and goats) particularly during the prolonged dry seasons would increase the average annual animal production by approximately 27%. Attention has been directed towards the necessity of utilization the marginal resources, i.e. saline soils and underground water for producing unconventional animal feed ingredients. The native natural rangelands constitute the principal feed resources in the Egyptian deserts. The biomass production and quality of the natural rangelands in such areas vary considerably from season to season and from area to area depending on several factors, mainly environmental factors (El Shaer, 1996). They are widely distributed throughout several regions of Egypt due to presence of numerous salines along the Mediterranean Sea and Red Sea shores and inlands (littoral salt marshes and inland salt marshes) as reported by Batanouny (1993).

Halophytes represent a major part of the natural ranged and particularly the perennials and shrubby ones (Zahran, 1982). The less and unpalatable plant species represent approximately 70% of the total coverage. Several attempts have been made towards utilization of such less and unpalatable halophytic plants through proper processing methods to improve their palatability and nutritional utilization. Ensiling halophytic plants with other feed ingredients appeared to be the most convenient processing method under the prevailing conditions of aridity in Egypt (El Shaer *et al.*, 1991; Abou El Nasr *et al.*, 1996) . This article aimed to shed lights on the potentialities of halophytes, particularly as animal fodders under the arid conditions of Egypt.

## Economic benefits and uses of halophytes

There are many usages of halophytes in Egypt, such uses will be discussed in brief as follows:

- Halophytes as fuelwood and coal: *Tamarix* spp. trees and *Acacia* spp. trees are most important ligneous plants as a good source for firewood and coal.
- As timber *Tamarix* spp., *Halexylon* spp., *Prosopis* spp. and *Avicennia* spp. are considered the main timber in Egypt for construction of roofs and some furniture.

- As fodders (range plants) Several halophytic plants represent the main source of animal feeds in Sinai and the North western coast of Egypt.
- As medicine the ash of some halophytes is, sometimes, used in the folk medicine, especially for wounds, scabies and burns, e.g. *Zygophyllum* spp. and *Avicennia* spp. (Batanouny, 1993).
- As wind breaks *Tamarix aphylla* and *Prosopis* spp. have been used for a long time as a windbreak in the desert areas.

## Nutritive value of halophytes

Halophytic plant species vary considerably in their chemical composition, nutritive value and palatability as indicated, in Table 1, from data cited by many investigators (El-Shaer, 1981; Abd El-Aziz, 1982; El-Bassosy, 1983; Anon 1998).

Table 1. Overall means of chemical composition (%, on DM basis) and palatability rate of most common halophytes in Sinai and the North Western Coast of Egypt.

| Plant species | PR | DM | Ash | CF | CP | EE | NFE |
|---|---|---|---|---|---|---|---|
| *Nitraria retusa* | A | 38.1 | 30.2 | 31.5 | 11.3 | 2.55 | 24.45 |
| *Atriplex halimus* | A | 35.0 | 23.1 | 26.2 | 13.2 | 2.30 | 35.20 |
| *Salsola tetrandra* | A | 38.0 | 36.1 | 34 2 | 6.77 | 2.41 | 20.52 |
| *Sueada fruticosa* | A | 24.1 | 14.2 | 30.1 | 12.1 | 5.00 | 38.60 |
| *Tamarix aphylla* | C | 35.1 | 20.1 | 14.2 | 12.2 | 3.52 | 49.98 |
| *Halocnemon strobilaceum* | C | 30.1 | 30.1 | 17.0 | 6.92 | 2.15 | 43.83 |
| *Tamarix mannifera* | G, C | 42.1 | 25.2 | 13.0 | 8.15 | 3.11 | 50.54 |
| *Haloxylom salicornicum* | Nil | 45.1 | 18.1 | 29.5 | 17.5 | 5.71 | 34.19 |
| *Zygophyllum album* | Nil | 27.7 | 30.2 | 13.7 | 6.75 | 2.33 | 47.02 |

PR: Palatability rate for animal species, S: sheep; *G: goat; C: ca*mel; A :All animals.

Data in Table 1 showed that most of halophytic shrubs contained moderate amounts of crude protein (CP) which it seems fair enough to cover the nitrogen requirements of grazing animals. They also contained high levels of fiber and ash contents, which could limit intake, and digestibility of such forages. Although, the protein content of some shrubs seems to be high; a large proportions of such protein is in the from of non-protein nitrogen (NPN). Therefore, available sources of energy should be supplemented to animals for better utilization and efficiently digestion. *N. retusa, S. fruticosa* and to some extents *A. halimus* could be considered as good fodders because of their palatability for all animal species, in addition to their moderate content of protein. *A. halimus* has been showed as slightly low palatable shrubs and are usually grazed during summer and autumn by sheep, goats and camels (El Shaer, 1981; Abd El Aziz, 1982).

## Utilization of fresh and dried halophytic fodders

Voluntary feed intake (VFI) and digestibility are considered the two major components reflecting upon forage quality of grazing ruminants. The process of aging and maturation of the ranges was found to be associated with a decline in digestibility, CP content and consequently nutritive value (El-Shaer, 1981; El-Bassosy, 1983 ). DMI and DM digestibility of halophytic forages were higher in grazing season than in drought season with both sheep and goats. Rams consumed less DMI of forages than bucks in drought season (34.4 *vs* 44.1 g/kg$^{0.75}$) as reported by El Shaer (1981). Warren *et al.* (1990) recorded dry matter intakes of 400-800 g/day for 4 species *(A. undulata, A. lentiformis, A. ammicolla and A. cinerea)* fed to sheep that had dry matter digestibilities of 53-62%. Le Houérou (1992) reported that sheep became adapted to saltbush and increased their intake of forage over a 3-5 month period. Organic constituents of halophytes are highly digestible by goats and sheep and that mixed diets containing halophyte forages are acceptable to sheep and goats. Most of halophyte shrubs are high in protein content and of moderate digestibility, but slightly deficient in soluble carbohydrates and need to be supplemented with available sources of energy as mentioned above.

El Shaer *et al.* (1990) found that DMI from the fresh edible parts of Z. *album, T. mannifera, A. halimus and H. strobilaceum* were 2.12, 10.9, 19.4 and 18.2 g / kg W$^{0.75}$ for sheep and 2.94, 10.3, 15.8 and 14.2 g/kg $W^{0.75}$ for goats, respectively as shown in table 2. In their air-dry state Z. *album was* not eaten and the DMI from *A. halimus* and *H. strobilaceum* were 13.2 and 9.45 g DM/kg $W^{0.75}$ for sheep and 21.0 and 8.23 g/kg $W^{0.75}$ for bucks, respectively (Table 3). On the other hand, DMI by sheep and goats from *T. mannifera* and A. *halimus* were markedly higher ($P < 0.05$) than that from Z. *album* and *H. strobilaceum,* since the fresh Z. *album* and *H. strobilaceum* are known to be unpalatable feeds. The poor intake of the fresh and air-dried halophytic species could be attributed to main three factors: i) high Na, Ca and silica; ii) higher levels of ADL and NDF; and iii) many shrubs containe higher levels of plant secondary metabolites (Anon, 1998). In Southern Sinai, Hassan *et al*. (1980) indicated that sheep lost weight during 12 months of the study period, but losses were minimal in the spring season (26 g/day) as compared to 134 g/day in summer season. In prolonged drought seasons, sheep and goats were not able to maintain their live weights even when the pasture reached its best condition (Hassan *et al*., 1980 ). Similar results were obtained by El Shaer, (1981) through two successive years. Rams lost weight in drought season (-47.8 g/day) but gained weight (24 g/day) in grazing season, whereas, bucks gained weight in both drought and grazing seasons (22.8 and 98.1 g/day, respectively). Kids raised on the salty pasture without supplementation gained 0.36 g/kg $W^{0.75}$ on the average, meanwhile, lambs lost 2.82 g/kg$W^{0.75}$.

Table 2. Dry matter intake (g DM/kg $W^{0.75}$) of halophytic species

| | Sheep (S) | Goat(G) | S/G Ratio |
|---|---|---|---|
| Fresh state: *A. halimus* | 19.4 | 15.8 | 1.23 |
| *H. strobilaceum* | 18.2 | 14.2 | 1.28 |
| *T mannifera* | 10.9 | 10.3 | 1.06 |
| *Z. album* | 2.12 | 2.94 | 0.72 |
| Air-dried state: *A. halimus* | 13.2 | 21.0 | 0.63 |
| *H. strobilaceum* | 9.45 | 8.23 | 1.15 |
| *T. mannifera* | 5.12 | 4.75 | 1.08 |
| *Z. album* | 0.00 | 0.00 | 0.00 |

Source: El Shaer *et al*. (1990).

Table 3. Overall averages of chemical composition, sodium and potassium a concentration of ensiled ingredients and silages (as% on DM basis)

| Criteria | DM | Ash | CP | CF | EE | Na | K | NDF | ADF | ADL |
|---|---|---|---|---|---|---|---|---|---|---|
| Ensiled ingredients: | | | | | | | | | | |
| *A. nummularia* | 40.4 | 25.5 | 12.2 | 16.1 | 2.10 | 4.50 | 2.30 | 60.5 | 33.1 | 10.3 |
| *A. saligna* | 44.8 | 10.6 | 8.80 | 22.3 | 2.40 | 1.10 | 1.10 | 63.0 | 44.1 | 18.4 |
| *T. mannifera* | 51.5 | 22.3 | 7.60 | 16.0 | 3.50 | 2.75 | 0.79 | 49.0 | 33.3 | 12.2 |
| *Z. album* | 36.0 | 26.9 | 6.40 | 16.0 | 4.40 | 2.80 | 1.26 | 44.9 | 31.4 | 13.2 |
| *H. strobilaceum* | 60.0 | 29.1 | 6.50 | 14.3 | 3.00 | 5.00 | 1.60 | 41.8 | 22.8 | 11.2 |
| Silages : | | | | | | | | | | |
| Silage 1 | 45.0 | 22.7 | 7.10 | 21.3 | 2.50 | 1.30 | 6.88 | 51.1 | 28.9 | 7.50 |
| Silage2 | 59.2 | 22.7 | 9.10 | 23.4 | 1.30 | 1.67 | 1.07 | 52.0 | 34.1 | 13.8 |
| Silage 3 | 45.7 | 20.8 | 8.40 | 11.2 | 1.50 | 2.25 | 1.20 | 42.7 | 28.6 | 13.2 |
| Silage4 | 47.4 | 22.6 | 7.20 | 17.8 | 1.60 | 1.60 | 0.95 | 50.5 | 33.5 | 13.8 |
| Silage5 | 48.1 | 23.4 | 13.9 | 14.2 | 2.30 | 2.00 | 1.40 | 40.6 | 25.4 | 11.0 |
| Silage 6 | 49.2 | 23.3 | 9.50 | 15.8 | 1.50 | 2.10 | 1.73 | 47.4 | 33 8 | 15.4 |
| Acacia silage | 37.1 | 13.1 | 10.2 | 25.3 | 4. 90 | - | - | 64.7 | 39.6 | 11.2 |
| Saltbush silage | 33.1 | 22.5 | 11.8 | 20.4 | 4.00 | - | - | 60.1 | 38.4 | 8.46 |

S1: *T. mannifera, Z. album, H. strobilaceum* and Molasses. At 30:30:30:10.
S2: *T. mannifera, Z. album, H. strobilaceum*, broiler litter, molasses. At 20:20:20:30:10.
S3: *T. mannifera, Z. album, H. strobilaceum*, anaerobic digested manure, molasses. At 20:20:20:30:10.
S4: *T. mannifera, Z. album, H. strobilaceum, A. nummularia, A. saligna*, molasses. At 15:15:15:18:27:10.
S5: *T. mannifera, Z. album, H. strobilaceum, A. nummularia, A. saligna*, broiler litter, molasses. At 10:10:10:12:18:30:10.
S6: *T. mannifera, Z. album, H. strobilaceum, A. nummularia, A. saligna*, anaerobic digested manure, molasses. At 10:10:10:12:18:30:10.

## Utilization of ensiled halophytes

The ensiling process improved the quality of halophytes and enhanced their acceptability for sheep and goats (El Shaer *et al*., 1991). Average value of proximate chemical and mineral constituents of ensiled ingredients and silages are summarized in Table 3. Concerning the ensiled materials, all halophytes attained reasonable crude protein levels ranged from 6.59% *(H. strobilaceum)* to 12.2% (*A. nummularia)* which seemed to be enough to cover the maintenance requirements of nitrogen for small ruminants (Kearl, 1982). Ash content varied greatly among halophytic species and ranged from 10.6% *(A. saligna)* to 29.1% *(H. strobilaceum).* A11 ensiled materials attained reasonable concentrations of sodium (Na) and potassium (K). However, the concentrations of Na and K in the ensiled materials, seemed to be above the dietary for requirements of ruminants (Kearl, 1982) without harmfull impact on livestock production.

Concerning the ensiled products, Table 3, it appeared that silage 5, which contained ensiled shrubs with broiler litter, contained the highest level of CP (13.9%) due to inclusion of broiler litter with the other ensiled materials. Silages 1 and 4 showed the lowest CP content (7.10 and 7.20%, respectively) since they included ensiled shrubs only without BL or ADM, in addition the ensiling process resulted in a decrease in CP content of silages (El Shaer *et al*., 1990 and 1991). However, the CP levels in the tested silages seemed to be reasonable to maintain the protein requirements of ruminants. Such higher Na and K concentrations of the tested silages appeared to be in normal ranges and enough to cover the requirements of ruminants (Kearl, 1982). Ensiling less or unpalatable halophytes with other feed ingredients would improve forage acceptability; consequently, forage intake would be also increased. Khamis (1988) reported that maximum intakes were recorded for goats and sheep fed *H. strobilaceum* and *A. halimus* followed closely by *T. aphylla,* whereas Z. *album* silage was much inferior (Table 4). As shown from data in Table 4, maximum silage intakes were recorded for sheep and goats fed both A. *halimus* and *H. strobilaceum* silages (approximately 59 g/kg $W^{0.75}$ ).

Table 4. Intake and digestion of halophytic silages by sheep and goats

| Items | *T. mannifera* | | *A. halimus* | | *Z. album* | | *H. strobilaceum* | |
|---|---|---|---|---|---|---|---|---|
| | Goats | Sheep | Goats | Sheep | Goats | Sheep | Goats | Sheep |
| DMI (g/kg $W^{0.75}$/day | 42.15 | 44.17 | 59.69 | 59.87 | 22.53 | 24.54 | 59.41 | 58.21 |
| Silage digestion (%) | | | | | | | | |
| DM | 51.54 | 50.81 | 60.72 | 58.09 | 49.89 | 47.32 | 66.05 | 61.67 |
| OM | 48.10 | 50.45 | 63.22 | 62.60 | 45.07 | 46.20 | 63.65 | 64.47 |
| CF | 42.42 | 45.65 | 67.44 | 54.26 | 21.30 | 40.46 | 64.37 | 64.23 |
| EE | 71.79 | 67.46 | 73.27 | 75.37 | 50.56 | 56.08 | 70.83 | 63.70 |
| NFE | 47.65 | 48.99 | 59.14 | 60.85 | 52.34 | 41.45 | 64.60 | 58.75 |
| TDN (g/kg $W^{0.75}$/day) | 17.34 | 18.70 | 32.52 | 32.22 | 8.81 | 9.64 | 29.84 | 28.67 |
| DCP (g/kg $W^{0.75}$/day | 2.93 | 3.20 | 5.62 | 6.37 | 1.62 | 1.95 | 4.56 | 5.56 |

It seems, therefore, that animals were able to cover their maintenance requirements. Also, voluntary intake was increased by ensiling a mixture of halophytic species, i.e. *A. halimus, H. strobilaceum, T. mannifera and Z. album* with ground date seeds.

Sheep and goats had positive nitrogen balance except when they were fed on Z. *album* silage. Animals, also, consumed more free water when fed *H. strobilaceum* silage as compared to the other three silages. On the same trend, in a study on goats and sheep fed some desert shrubs ensiled with broiler litter in Sinai, El-Shaer *et al*. (1990) reported that ensiling these forages with broiler litter (BL) improved their palatability and DMI as compared with fresh and air-dried materials . They added also that ensiling such shrubs with broiler litter prevent nitrogen losses and enhance the conversion of the available NPN into true protein. Also, El Shaer *et al*. (1991) reported that ensiling *H. strobilaceum* with BL and molasses increased animal acceptability and intake of goats by 13% over the control diet (berseem hay) as has been summarized in Table 4. Three natural shrubs *(T. mannifera, Z. album* and *H. strobilaceum)* and two cultivated shrubs *(A. nummularia* and *A. saligna)* were ensiled in different proportions with some other feed ingredients to formulate six silages (El Shaer *et al*., 2000). Feeding and digestibility trials were conducted on 30 mature Baladi male goats in equally 6 treatments. Animals in the first three treatments T1, T2, and T3 were fed on a mixture of the fresh cultivated shrubs in addition to one of the silages: S1, S2 and S3, whereas those in T4, T5 and T6 were fed on

S4, S5 and S6 as sole basal diets (El Shaer *et al*., 2000). Data from this study indicated that voluntary intake gradually increased and reached the peak in the 4th week of feeding trial. Data from the metabolism trial indicated that the highest silage intake was attained for animals fed silage 5 (32.5 g DM/ Kg BW and 5.01 g CP/kg BW) which contained the ensiled materials of natural and cultivated shrubs. Meanwhile, the lowest intakes were recorded for animals in T6. Digestibility coefficients of DM, CP and OM significantly ($P<0.05$) varied among treatments. Goats fed silage 5 attained the maximum TDN and DCP intakes. Nitrogen retention was positive for all animal groups except for those in T2 and T6. Animals in all treatments showed a positive Na balance and retained various amount of Na. Similar trends were showed for K retention except for those in T1 and T2. Based on the above mentioned trends silage 5 would be highly recommended as a good quality basal diet for goats. El Shaer *et al*. (1991) illustrated the performance of sheep and goats fed eiyher *H. strobilaceum* with broiler litter silage (HS-BL silage) or the control diet (berseem hay) in Table 5. The data showed that sheep gained slightly similar gain when they were fed on berseem hay and the tested silage (HS- BL silage) whereas goats fed the HS-BL silage were gained more than those fed the berseem hay (72 *vs.* 65 g). Feeding such silage appeared to be more economic since feed costs decreased about one third in comparison with the conventional diet.

Table 5. Growth of sheep and goats fed halophytic silage and feed conversion

| Item | Sheep | | Goats | |
|---|---|---|---|---|
| | *Berseem hay* | HS-BL[1] silage | *Berseem hay* | HS-BL[1]silage |
| Average daily gain (g) | 71.6 | 73.3 | 65.0 | 71.7 |
| Average daily DMI, g/kg $w^{0.75}$ | 70.8 | 74.3 | 66.2 | 77.0 |
| Feed conversion ratio : | | | | |
| Kg DM feed/kg gain | 14.0 | 14.2 | 11.1 | 11.9 |
| Kg TDN/kg gain | 6.88 | 7.78 | 5.67 | 5.89 |
| Feed cost, LE[2] | 3.79 | 1.21 | 3.02 | 1.01 |

1: HS-BL silage: *H. strobilaceum*-broiler litter silage.
2: L.E.: Egyptian pound.

On the other hand, Abou El-Nasr *et al*. (1996) reported that low intake of the saltbush hay, fresh *Acacia* hay affected body weight changes of sheep as they tended to lose weight. In contrast, sheep fed saltbush silage gained weight (91.1 g/day).

In general, all data on processing halophytes as silages would recommend such silage mixtures of natural and cultivated halophytic shrubs incorporated with other feed materials as good animal feeds that can be used economical and efficiently.

## Conclusion

Alternative feed resources, particularly from such halophytic plant materials, in addition to the palatable one could provide additional feeds for livestock on the rangelands as well as protect the natural ranges from overgrazing and further deterioration. These halophytic plant species may play an important role for welfare of Bedouins living in such arid areas through providing economic feeds allover the year. Additionally cultivation of some halophytic species on saline non-productive soils to be irrigated with saline or brackish water will, also, be a good approach for providing good quality fodders and increase animal products for human in such areas.

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